

**\* NOTICES \***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

---

**DETAILED DESCRIPTION**

---

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the dielectric antenna which uses complex-dielectrics material and this complex-dielectrics material.

[0002]

[Description of the Prior Art]Conventionally, what consists of a dielectric ceramic simple substance or a resin simple substance is proposed as a surface mount type dielectric antenna used for mobile communications equipment and wireless LAN, such as a cellular phone. For example, the surface mount type dielectric antenna with which an antenna base consists of a ceramic simple substance or a resin simple substance is indicated by JP,9-98015,A. The styrene system polymer and inorganic bulking agent which have syndiotactic structure, the rubber-like elasticity object, and the Plastic solid which has the plating nature which consists of a composite material which consists of thermoplastics are indicated by JP,9-221573,A. The Plastic solid which blended styrene system block polymer which is a rubber-like elasticity object as a compatible agent with the styrene system polymer which has syndiotactic structure is indicated by JP,9-263663,A and JP,10-17739,A. The manufacturing method of the foam of a styrene system polymer which has the syndiotactic structure which has plating nature is indicated by JP,10-45936,A further again.

[0003]

[Problem(s) to be Solved by the Invention]By the way, also in the dielectric antenna, the demand of the weight saving and the miniaturization is increasing with the weight saving of mobile communications equipment, such as a cellular phone, and the miniaturization in recent years. However, the respectively following faults were among the antenna which consists of the conventional dielectric ceramic simple substance, or the antennas which consist of a resin simple substance.

[0004]That is, it was difficult for a forming cycle, a baking process, etc. of an antenna base not only to take time, but to be inferior to processability and a moldability and to create a complicated-shaped antenna in the antenna which consists of a dielectric ceramic simple

substance. Although an antenna can be miniaturized by enlarging a dielectric constant, since an antenna characteristic will be extremely reduced if there is a size effect in an antenna and it is made small too much, there is a limit in the miniaturization of an antenna. Therefore, the specific gravity of the construction material of an antenna becomes important at the weight saving of an antenna. However, dielectric ceramics also had the problem that specific gravity was large and it could not respond to the weight saving of an antenna. On the other hand, although the specific gravity of resin was small and being excelled in a moldability and processability in the antenna which consists of a resin simple substance, since specific inductive capacity was small, there was a problem that it could not respond to the miniaturization of an antenna.

[0005] Since there being the circuit board for mounting a dielectric antenna towards high-density-assembly correspondence and use of lead free solder spread, there is much number of times of a reflow to which a dielectric antenna is exposed, and it is in the tendency for reflow temperature to also become high. Therefore, the needs of the dielectric antenna of high heat resistance are strong.

[0006] Then, the purpose of this invention has a good electrical property at high heat resistance, and there is in providing the dielectric antenna which was excellent in processability and a moldability, and uses a small complex-dielectrics material and this complex-dielectrics material of specific gravity.

[0007]

[Means for Solving the Problem and its Function] Matrix resin with which complex-dielectrics material applied to this invention in order to attain said purpose mixed a styrene system polymer which has syndiotactic structure, and liquid crystal polyester resin, Or an inorganic bulking agent of acid and alkali meltable to any at least one was mixed to matrix resin which mixed a styrene system polymer and liquid crystal polyester resin which have syndiotactic structure, and a rubber-like elasticity object.

[0008] Said inorganic bulking agent of acid and alkali meltable to any at least one was mixed to said matrix resin, and it left fluoric acid to it and ceramics insoluble to other acid and alkali were mixed to it.

[0009] Matrix resin receives 35 to 99 volume %, an inorganic bulking agent receives one to 45 volume %, as for ceramics, a volume ratio of zero to 35 volume %, a styrene system polymer of matrix resin, and polyester resin receives matrix resin, and 0.25-4.0, and a rubber-like elasticity object are zero to 30 volume %.

[0010] By the above composition, since a styrene system polymer which has syndiotactic structure is low  $\tan \delta$  and its specific gravity is small, complex-dielectrics material becomes a light weight from dielectric materials which consist of a ceramic simple substance. And this complex-dielectrics material excels dielectric materials which consist of a ceramic simple substance in processability and a moldability. Specific inductive capacity of liquid crystal polyester resin is large, it excels in heat resistance, and high plating adhesion strength is demonstrated by using a meltable inorganic bulking agent together to

acid or alkali.

[0011]A rubber-like elasticity object gives rubber elasticity to complex-dielectrics material, and raises plating film peel strength, and internal stress generated into complex-dielectrics material is distributed. And by adopting a meltable thing as acid or alkali as a material of an inorganic bulking agent, in a process of forming a plating film in a molded body surface of complex-dielectrics material, surface roughening of a molded body surface is promoted and an anchor effect of a plating film improves.

[0012]On the other hand, since specific inductive capacity of ceramics is large, a dielectric antenna using complex-dielectrics material which consists of matrix resin, ceramics, etc. becomes smaller than a dielectric antenna using dielectric materials which consist of a resin simple substance. Since ceramics do not begin to melt even if complex-dielectrics material is immersed in other acid and alkali other than fluoric acid by leaving fluoric acid and adopting insoluble ceramics as other acid and alkali, the physical properties of complex-dielectrics material are stable.

[0013]

[Embodiment of the Invention]The embodiment of the dielectric antenna which uses hereafter the complex-dielectrics material and it which start this invention with reference to an attached drawing is described.

[0014]One embodiment of the dielectric antenna concerning this invention is shown in drawing 1. This dielectric antenna 1 comprises the antenna base 2, the input electrode 4, the radiation electrode 5, and the ground electrode 6 of rectangular parallelepiped shape.

[0015]As a material of the antenna base 2, the following four kinds of complex-dielectrics materials are used. The styrene system polymer in which the 1st complex-dielectrics material has syndiotactic structure. It is the complex-dielectrics material which mixes the inorganic bulking agent of acid and alkali meltable to any at least one to the matrix resin which mixed (it is hereafter described as SPS), and liquid crystal polyester resin (it is hereafter described as LCP). The 2nd complex-dielectrics material is a complex-dielectrics material which mixes the inorganic bulking agent of acid and alkali meltable to any at least one to the matrix resin which mixed SPS, LCP, and a rubber-like elasticity object. The 3rd complex-dielectrics material is a complex-dielectrics material which leaves fluoric acid to the matrix resin which mixed SPS and LCP, and mixes ceramics insoluble to other acid and alkali with the inorganic bulking agent of acid and alkali meltable to any at least one to it. The 4th complex-dielectrics material is a complex-dielectrics material which leaves fluoric acid to the matrix resin which mixed SPS, LCP, and a rubber-like elasticity object, and mixes ceramics insoluble to other acid and alkali with the inorganic bulking agent of acid and alkali meltable to any at least one to it. Powder with a particle diameter of 0.1-50 micrometers is 10 volume % Added and stirred to 30-40 "meltable to any at least one of acid and the alkali" \*\* acid here or alkali, and what is dissolved thoroughly visually is pointed out within 5 minutes.

[0016]Here, in the process of forming a plating film in the surface of the antenna base 2,

"acid" and "alkali" are acid and alkali for carrying out surface roughening of the surface of the antenna base 2, as mentioned later. SPS is used maintaining good dielectric characteristics by the high frequency which general-purpose atactic polystyrene (general-purpose PS) has because it excels in solvent resistance and heat resistance. As what has low  $\tan\delta$  and heat resistance, although there are PTFE system resin, a liquid crystal polymer, etc., PTFE resin is inferior to SPS in respect of a moldability, cost, and plating nature, and a liquid crystal polymer is inferior to SPS in respect of a moldability, cost, and dielectric characteristics. Specific inductive capacity of LCP is large, it is excellent in heat resistance, and demonstrates high plating adhesion strength by using a meltable inorganic bulking agent together to acid or alkali.

[0017]Ceramics insoluble to other acid and alkali other than fluoric acid are added in order to make the specific inductive capacity of complex-dielectrics material raise. As insoluble ceramics, by high frequency, perovskite system oxide paraelectrics, such as  $\text{CaTiO}_3$  with a small dielectric dissipation factor ( $\tan\delta$ ), and  $\text{SrTiO}_3$ , Perovskite system oxide ferroelectrics, such as  $\text{BaTiO}_3$ , and the mixture of those,  $\text{BaO-Nd}_2\text{O}_3\text{-TiO}_2$ , etc. are used.

When ceramics meltable to acid or alkali immerse complex-dielectrics material in an oxidizer, they begin to melt, and since the physical properties of complex-dielectrics material show dispersion, they cannot be used.

[0018]Give rubber elasticity to complex-dielectrics material and plating film peel strength is raised, and a rubber-like elasticity object is added in order to distribute the internal stress generated into complex-dielectrics material. If a meltable rubber-like elasticity object is adopted as acid, the anchor effect of a plating film can be promoted. As a rubber-like elasticity object, general-purpose diene system rubber with high rubber elasticity, thermoplastic rubber, etc. are used. At this embodiment, the block copolymer (SEBS) of heat-resistant high styrene ethylene-butylene-styrene was adopted by the thermoplastic rubber which does not need to be constructed for which a bridge and ground, especially a styrene system.

[0019]Plating film peel strength is raised, and the inorganic bulking agent of acid and alkali meltable to any at least one is added in order to reduce the cost of complex-dielectrics material. The meltable inorganic bulking agent was adopted as acid or alkali in order to promote the anchor effect of a plating film, and it can raise plating adhesion further to acid or alkali as compared with an insoluble inorganic bulking agent. As a soluble inorganic bulking agent, it can choose from the groups which consist of the oxide of the periodic table IIa or an IIb group element, carbonate, sulfate, phosphate, and silicate. Since it is meltable to acid, each of these things has the effect of raising plating adhesion, but calcium carbonate is especially suitable from the ease of carrying out of pretreatment of plating film formation, and a point of the manufacturing cost.

[0020]and complex-dielectrics material -- matrix resin receives 35 to 99 volume %, an inorganic bulking agent receives one to 45 volume %, in ceramics, the volume ratio of SPS

and LCP of zero to 35 volume % and matrix resin receives matrix resin, and 0.25-4.0, and a rubber-like elasticity object are set up within the limits of 0 - 30 volume %.

[0021]The input electrode 4 is formed in the near-side end of the antenna base 2. The radiation electrode 5 was formed in the upper surface center part of the antenna base 2, and has extended in linear shape at the longitudinal direction of the antenna base 2. The length of the radiation electrode 5 is  $\lambda/4$  ( $\lambda$ : center wavelength within the antenna base 2). One end 5a of the radiation electrode 5 set the predetermined interval 7, and has countered the input electrode 4. The end 5b of another side of the radiation electrode 5 is surroundings \*\*\*\*, and has electrically connected the back side edge of the antenna base 2 to the ground electrode 6 provided all over the abbreviated undersurface of the antenna base 2.

[0022]Since the dielectric antenna 1 which consists of the above stripline composition has the small specific gravity of SPS or LCP, the weight saving of the antenna base 2 can be attained. Since LCP is excellent in heat resistance, it can also bear a repetition of a reflow and an elevated-temperature reflow using lead free solder. Since the antenna base 2 consists of complex-dielectrics materials, such as LCP with large SPS of low tandelta and specific inductive capacity, the dielectric antenna 1 which has the stable antenna characteristic can be obtained.

[0023]Next, as shown in Table 1 - 6, various composition ratios and constituents of complex-dielectrics material were made to change, and dielectric characteristics, plating peel strength, a bending examination, and change of specific gravity were measured. After rough-mixing SPS, LCP, etc. which carried out weighing by the capacity factor shown in Table 1 - 6, the composite material pellet was manufactured using the biaxial extruder. The cylinder temperature at the time of biaxial extrusion was 290 \*\*.

[0024]

[Table 1]

表 1

	実施例 1	比較例 1	実施例 2	実施例 3	実施例 4	実施例 5
SPS(A) (体積%)	4.9	60	19.8	59.4	79.2	39
LCP(B) (体積%)	19.6	40	79.2	39.6	19.8	26
ゴム状 弾性体(C) (体積%)	10.5	0	0	0	0	0
SPS/LCP (体積%)	0.25	1.5	0.25	1.5	4.0	1.5
$\frac{C \times 100}{A+B+C}$ (%)	30	0	0	0	0	0
A+B+C (体積%)	35	100	99	99	99	65
セラミックス (体積%)	35	0	0	0	0	17.5
無機充填材 (体積%)	30	0	1	1	1	17.5
$\epsilon_r$ (3GHz)	20.0	3.1	4.0	3.2	3.0	7.9
Q(3GHz)	208	7500	4800	7000	9800	950
ピール強度 (kg/cm)	0.52	0.10	0.80	1.45	1.38	0.78
リフロー 2回後 撓み試験	○	×	○	○	○	○
リフロー 3回後 撓み試験	○	×	○	○	○	○
高温 リフロー後 撓み試験	○	×	○	○	○	○
比重	2.58	1.08	1.17	1.10	1.06	1.86

[0025]

[Table 2]

表 2

	実施例 6	比較例 2	実施例 7	実施例 8	比較例 3	実施例 9
SPS(A) (体積%)	21	18	50.4	38.4	35.4	45
LCP(B) (体積%)	14	12	33.6	25.6	23.6	30
ゴム状 弾性体(C) (体積%)	0	0	0	0	0	0
SPS/LCP (体積%)	1.5	1.5	1.5	1.5	1.5	1.5
$\frac{C \times 100}{A+B+C}$ (%)	0	0	0	0	0	0
A+B+C (体積%)	35	30	84	64	59	75
セラミックス (体積%)	32.5	35	15	35	40	0
無機充填材 (体積%)	32.5	35	1	1	1	25
$\epsilon_r$ (3GHz)	17.5	20.5	5.8	13.1	16.6	4.3
Q (3GHz)	260	210	2500	210	195	2800
ピール強度 (kg/cm)	0.60	0.55	1.10	0.65	0.50	1.80
リフロー 2 回後 撓み試験	◎	◎	◎	◎	◎	◎
リフロー 3 回後 撓み試験	◎	◎	◎	◎	×	◎
高温 リフロー後 撓み試験	◎	×	◎	◎	×	◎
比重	2.52	2.63	1.52	2.08	2.23	1.49

[0026]

[Table 3]

表 3

	実施例 10	比較例 4	比較例 5	実施例 11	実施例 12
SPS(A) (体積%)	33	30	0	13	39
LCP(B) (体積%)	22	20	65	52	26
ゴム状 弾性体(C) (体積%)	0	0	0	0	0
SPS/LCP (体積%)	1.5	1.5	0	0.25	1.5
$\frac{C \times 100}{A+B+C}$ (%)	0	0	0	0	0
A+B+C (体積%)	55	50	65	65	65
セラミックス (体積%)	0	0	15	15	15
無機充填材 (体積%)	45	50	20	20	20
$\epsilon_r$ (3GHz)	5.5	5.9	9.4	8.6	7.4
Q (3GHz)	202	180	195	280	420
ピール強度 (kg/cm)	0.80	0.80	0.90	0.85	0.80
リフロー 2 回後 撓み試験	◎	×	◎	◎	◎
リフロー 3 回後 撓み試験	◎	×	◎	◎	◎
高温 リフロー後 撓み試験	◎	×	◎	◎	◎
比重	1.81	1.89	1.90	1.88	1.83

[0027]

[Table 4]

表 4

	実施例 13	比較例 6	実施例 14	実施例 15	比較例 7
SPS(A) (体積%)	52	54.2	33.1	27.3	25.3
LCP(B) (体積%)	13	10.8	22.1	18.2	16.9
ゴム状 弾性体(C) (体積%)	0	0	9.8	19.5	22.8
SPS/LCP (体積%)	4.0	5.0	1.5	1.5	1.5
$\frac{C \times 100}{A+B+C}$ (%)	0	0	15	30	35
A+B+C (体積%)	65	65	65	65	65
セラミックス (体積%)	15	15	15	15	15
無機充填材 (体積%)	20	20	20	20	20
$\epsilon_r$ (3GHz)	6.8	6.7	7.2	7.0	6.9
Q(3GHz)	1100	1500	390	320	280
ピール強度 (kg/cm)	0.65	0.52	0.90	0.95	0.96
リフロー 2 回後 撓み試験	◎	◎	◎	◎	◎
リフロー 3 回後 撓み試験	◎	◎	◎	◎	◎
高温 リフロー後 撓み試験	◎	×	◎	◎	×
比重	1.80	1.80	1.81	1.79	1.79

[0028]

[Table 5]

表 5

	実施例 16	実施例 17	実施例 18	実施例 19	実施例 20
SPS(A) (体積%)	29.25	42.5	29.25	29.25	29.25
LCP(B) (体積%)	29.25	42.5	29.25	29.25	29.25
ゴム状 弾性体(C) (体積%)	6.5	0	6.5	SBR 6.5	マレイン酸変性 SEBS 6.5
SPS/LCP (体積%)	1.0	1.0	1.0	1.0	1.0
$\frac{C \times 100}{A+B+C}$ (%)	10	0	10	10	10
A+B+C (体積%)	65	85	65	65	65
セラミックス (体積%)	BaTiO <sub>3</sub> 15	BaTiO <sub>3</sub> 15	SrTiO <sub>3</sub> 15	15	15
無機充填材 (体積%)	20	0	20	20	20
$\epsilon_r$ (3GHz)	7.7	6.2	7.6	7.3	7.6
Q(3GHz)	1400	2400	1500	1550	1400
ピール強度 (kg/cm)	0.97	0.72	0.96	0.90	1.05
リフロー 2回後 撓み試験	◎	◎	◎	◎	◎
リフロー 3回後 撓み試験	◎	◎	◎	◎	◎
高温 リフロー後 撓み試験	◎	◎	◎	◎	◎
比重	2.17	1.89	1.96	1.88	1.87

[0029]

[Table 6]

表 6

	実施例 21	実施例 22	実施例 23
SPS(A) (体積%)	29.25	29.25	4.9
LCP(B) (体積%)	29.25	29.25	19.6
ゴム状 弾性体(C) (体積%)	6.5	6.5	10.5
SPS/LCP (体積%)	1.0	1.0	0.25
$\frac{C \times 100}{A+B+C}$ (%)	10	10	30
A+B+C (体積%)	65	65	35
セラミックス (体積%)	15	15	0
無機充填材 (体積%)	ピロリン酸 Ca 20	硫酸 Ba 20	65
$\epsilon_r$ (3GHz)	7.5	7.4	5.0
Q (3GHz)	1600	1550	1200
ピール強度 (kg/cm)	0.99	0.90	0.88
リフロー 2 回後 撓み試験	◎	◎	◎
リフロー 3 回後 撓み試験	◎	◎	◎
高温 リフロー後 撓み試験	◎	◎	◎
比重	1.94	2.23	1.86

[0030] In the case of Examples 1-15, 19-22 and the comparative examples 1-7,  $\text{CaTiO}_3$  with a mean particle diameter of 1.2 micrometers is used as ceramics powder here, In the case of Example 18,  $\text{SrTiO}_3$  with a mean particle diameter of 1.3 micrometers was used, and, in the case of Examples 16 and 17,  $\text{BaTiO}_3$  with a mean particle diameter of 2.0 micrometers was used. In the case of Examples 1-18, 21-23 and the comparative examples 1-7, as a rubber-like elasticity object, the block copolymer (Clayton G1650 made from shell JAPAN) of styrene ethylene-butylene-styrene is used, In the case of Example 19, the styrene butadiene rubber (60% of Nippon Zeon 2057S-styrene content) was used, and, in the case of Example 20, the maleic acid denaturation SEBS (Clayton FG1901 made from shell JAPAN X) was used. As an inorganic bulking agent, in the case of Examples 1-20, and 23 and the comparative examples 1-7,  $\text{CaCO}_3$  with a mean particle diameter of 2.6 micrometers was used, in the case of Example 21, calcium pyrophosphate with a mean particle diameter of 0.5 micrometer was used, and, in the case of Example 22, barium sulfate with a mean particle diameter of 1 micrometer was used.

[0031] The manufactured composite material pellet was used and the circular evaluation plate 50 mm in diameter whose board thickness is 1.3 mm was fabricated in injection

molding process. This injection molding process can fabricate the thing of the complicated shape of a dielectric antenna etc. easily in a short time. And what is necessary is just to apply the heat of the grade to which melting of SPS or LCP is carried out in the case of injection molding, and the temperature of not less than 1000 °C is unnecessary like ceramic firing. The plating film was formed in the surface of the fabricated evaluation plate by the following processes.

[0032]First, surface roughening of the surface of an evaluation plate was etched and carried out. The volume ratio (SPS/LCP) of SPS and LCP of matrix resin of complex-dielectrics material was smaller than 1.0, and when an inorganic bulking agent was more than 20 volume %, the alkali etching method was adopted. When other, the chromic acid etching method was adopted.

[0033]The alkali etching method immerses an evaluation plate in surface-active agent solution for 3 minutes, and carries out degreasing washing of the surface of an evaluation plate. Next, a potassium hydrate immerses an evaluation plate in the solution of 40 volume % for 5 minutes. Since a meltable inorganic bulking agent is etched into the alkali exposed on the surface of the evaluation plate with a potassium hydrate and the surface roughening of the surface of an evaluation plate is promoted, the anchor effect of the plating film formed on the surface of an evaluation plate becomes large. Next, after immersing an evaluation plate in dilute-hydrochloric-acid liquid for 5 minutes and making it neutralize, it rinses enough.

[0034]On the other hand, a chromic acid etching method immerses an evaluation plate in surface-active agent solution for 3 minutes, and carries out degreasing washing of the surface of an evaluation plate. Next, the chromic anhydride which is an oxidizer of a chromic-acid system about an evaluation plate (400g [l. ] solution): It is immersed in the mixed liquor of sulfuric acid (400g [l. ] solution) =1:1 for 10 minutes. Since a meltable rubber-like elasticity object and inorganic bulking agent are etched into the acid exposed on the surface of the evaluation plate with an oxidizer and the surface roughening of the surface of an evaluation plate is promoted, the anchor effect of the plating film formed on the surface of an evaluation plate becomes large. Then, an evaluation plate is rinsed enough.

[0035]Next, after the surface carried out immersion (conditioner process) of the evaluation plate by which surface roughening was carried out to cation system surface-active agent liquid for 5 minutes, it was immersed in the chloride aqueous acids of a palladium chloride / chloridation tin for 5 minutes, and palladium was made to adhere on the surface of an evaluation plate (catalyst process). Next, the evaluation plate was immersed in the hydrochloric acid aqueous solution for 5 minutes (accelerator process). Then, the evaluation plate was immersed in the copper sulfate alkaline aqueous solution for 20 minutes, and a 0.05-0.1-micrometer non-electrolytic copper plating film was formed on the surface of the evaluation plate. The electrolytic copper plating film was formed on the non-electrolytic copper plating film, and the plating film which has a thickness of a total of ten -

70 micrometers was formed.

[0036]In this way, about each obtained sample, the result of having carried out measurement of dielectric characteristics and plating film peel strength is shown in Table 1 - 6. The method of perturbation which computes specific inductive capacity and a dielectric dissipation factor from resonance frequency and unloaded Q was used for measurement of dielectric characteristics. Measurement of plating film peel strength measured the load at the time of tearing off this strip-of-paper-like pattern from an evaluation plate in the state where it is the length direction of a strip of paper, and the raising direction always becomes vertical to an evaluation plate, after it etched the plating film and width formed the 45-mm-long strip-of-paper-like pattern [ in 10 mm ]. Vertical \*\*\*\*\* carries out and speed is 0.9 mm/s.

[0037]The bending examination and specific gravity which are indicated in Table 1 - 6 were measured using the dielectric antenna 1 (refer to drawing 1) manufactured on the following conditions. After rough-mixing SPS, LCP, etc. which carried out weighing by the capacity factor shown in Table 1 - 6, the composite material pellet was manufactured using the biaxial extruder. After carrying out predrying of this pellet at the temperature of 120 \*\* for 3 hours, the antenna base 2 of rectangular parallelepiped shape was fabricated in injection molding process. At this time, the injection speed set molding temperature as 290 \*\*, and was set as 50 mm/s, and dwelling was set as 500 kg/cm<sup>2</sup>.

[0038]A plating film is formed in the surface of the fabricated antenna base 2 at the above-mentioned plating film formation process and the same process. However, as for a plating film, non-electrolytic copper plating is laminated for 3-4 micrometers in thickness, and electrolysis nickel plating in 0.1 micrometer in thickness, and 1-2 micrometers in thickness and the order whose electrolysis gilding electrolytic copper plating is 0.1 micrometer in thickness. When electrolytic copper plating was formed at this time, resist was applied on the electrolytic copper plating film using the patterned metal mask, it etched with ferric chloride, and patterning of the input electrode 4, the radiation electrode 5, and the ground electrode 6 was performed.

[0039]A bending examination mounts the manufactured dielectric antenna 1 in the 1.6-mm-thick circuit board with reflow solder, and does the three point bending examination (1 mm of 90 mm of beam + aggressiveness) of the circuit board. Then, the appearance of the dielectric antenna 1 is observed, and when normal, a crack and bulging have occurred on O and a plating film and lack has occurred on x and a plating film, it judges with xx. Peak temperature is 235 \*\* and the temperature conditions of reflow solder are not less than (for 60 seconds) 200 \*\*. Peak temperature is 275 \*\* and the temperature conditions of elevated-temperature reflow solder are not less than (for 60 seconds) 240 \*\*. Measurement of specific gravity was measured with the underwater substitution method. Water temperature was 23 \*\*.

[0040]As shown in Table 1 - 6, in the case of the dielectric antenna 1 of Examples 1-23. In matrix resin, 35 to 99 volume % and an inorganic bulking agent That is, one to 45 volume

%, In the volume ratio of SPS and LCP of zero to 35 volume %, and matrix resin, 0.25-4.0, and a rubber-like elasticity object to matrix resin in the case of the range of 0 - 30 volume %, [ ceramics ] Specific-inductive-capacity  $\epsilon_r$  is in about 3.0 to 20 range at 3 GHz, and unloaded Q has a value which exceeds 200 at 3 GHz, Plating film peel strength is over 0.5 kg/cm, and abnormalities are not accepted by bending examination, either, but specific gravity is smaller than 2.6 and becomes small substantially as compared with the specific gravity (about 3.80) of a ceramic simple substance.

[0041]On the other hand, radio-frequency head articles, such as a dielectric antenna, require the thing of the surface mount type by which a surface mount is carried out to the circuit board, while having specific-inductive-capacity  $\epsilon_r$  of about 3.0-20. If the content of SPS is too high, specific-inductive-capacity  $\epsilon_r$  becomes smaller than 3.0, and a dielectric antenna cannot be miniaturized. Since the mechanical strength of complex-dielectrics material falls in being less than 35 volume % as the matrix resin which consists of SPS and LCP shows the comparative example 2 of Table 2, plating adhesion strength falls or a moldability worsens.

[0042]As the volume ratio of SPS and LCP of matrix resin shows the comparative example 6 of Table 4, in being larger than 4.0, fault -- complex-dielectrics material cannot bear an elevated-temperature reflow -- arises. On the contrary, as the volume ratio of SPS and LCP of matrix resin shows the comparative example 5 of Table 3, in being smaller than 0.25, unloaded Q falls.

[0043]When complex-dielectrics material is manufactured only by SPS and LCP as shown in the comparative example 1 of Table 1 since SPS and LCP of matrix resin are etched with neither acid nor alkali, they cannot obtain sufficient peel strength. Then, it is necessary to add the inorganic bulking agent which can be etched with acid or alkali. If 45 volume % is exceeded as shown in the comparative example 4 of Table 3, an inorganic bulking agent will be etched too much with acid or alkali, and much micropores will also generate the inorganic bulking agent in the layer part of complex-dielectrics material. As a result, the mechanical strength of complex-dielectrics material falls and plating adhesion strength also falls.

[0044]A rubber-like elasticity object serves as a compatibilizer between SPS and LCP, makes UMISHIMA structure detailed, and raises plating adhesion strength. However, if a rubber-like elasticity object exceeds 30 volume % to matrix resin as shown in the comparative example 7 of Table 4, the dielectric characteristics of complex-dielectrics material and heat resistance will fall. That is, even if peel strength is high, it becomes a rejection by the bending examination after a reflow. Since ceramics cannot fully apply to resin in a mixing step when 35 volume % is exceeded, as insoluble ceramics are shown in the comparative example 3 of Table 2, complex-dielectrics material becomes weak and plating adhesion strength falls.

[0045]the dielectric antenna which uses the complex-dielectrics material and it concerning

this invention is not limited to said embodiment, within the limits of the gist, can be boiled variously and can be changed.

[0046]

[Effect of the Invention]The temperature of the grade to which thermofusion of SPS or LCP is carried out may be sufficient as the temperature which needs the complex-dielectrics material concerning this invention for shaping, and it is unnecessary like calcination of ceramics so that clearly also from the above explanation. [ of a high temperature ] Injection molding is possible, it can fabricate in easy and efficient complicated shape, a plating electrode can also be formed easily, and, moreover, a through hole etc. can be conjointly formed easily with the adhesion strength being high. Since SPS is excellent in the high frequency characteristic, the radio-frequency head article which has the electrical property which was excellent in high relative permittivity and low tandelta also in the GIGAHERUTSU belt can be obtained. Therefore, the complex-dielectrics material which consists of SPS, LCP, etc. becomes a light weight from the dielectric materials which consist of a ceramic simple substance in the case of the same specific inductive capacity.

[0047]Since LCP is excellent in high heat resistance, it is a repetition (since a chip may be mounted in the surface and rear surface of the circuit board, a reflow is to 2 times, but usually.) of three reflows or more. the tendency which the number of times of a reflow increases by complicated shape-ization of remounting a chip or the circuit board -- it is -- an elevated-temperature reflow which uses lead free solder can also be borne. Since the rubber-like elasticity object is added, internal stress is eased and it is hard to generate the poor modification at the time of reflow solder.

---

[Translation done.]

\* NOTICES \*

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.\*\*\*\* shows the word which can not be translated.

3.In the drawings, any words are not translated.

---

## CLAIMS

---

[Claim(s)]

[Claim 1]Complex-dielectrics material mixing an inorganic bulking agent of acid and alkali meltable to any at least one to matrix resin which mixed a styrene system polymer which has syndiotactic structure, and liquid crystal polyester resin.

[Claim 2]Complex-dielectrics material mixing an inorganic bulking agent of acid and alkali meltable to any at least one to matrix resin which mixed a styrene system polymer and liquid crystal polyester resin which have syndiotactic structure, and a rubber-like elasticity object.

[Claim 3]Complex-dielectrics material characterized by an inorganic bulking agent of acid and alkali meltable to any at least one, and having left fluoric acid and mixing ceramics insoluble to other acid and alkali at matrix resin which mixed a styrene system polymer which has syndiotactic structure, and liquid crystal polyester resin.

[Claim 4]To mixed matrix resin, a styrene system polymer and liquid crystal polyester resin which have syndiotactic structure, and a rubber-like elasticity object Acid and an inorganic bulking agent of alkali meltable to any at least one, Complex-dielectrics material having left fluoric acid and mixing insoluble ceramics to other acid and alkali.

[Claim 5]Said matrix resin is 35 to 99 volume %, and said inorganic bulking agent is one to 45 volume %, Claim 1, wherein said ceramics are zero to 35 volume %, volume ratios of a styrene system polymer of said matrix resin and liquid crystal polyester resin are 0.25-4.0 and said rubber-like elasticity object is zero to 30 volume % to said matrix resin thru/or the complex-dielectrics material according to claim 4.

[Claim 6]A dielectric antenna comprising:

An antenna base which consists of any at least one of claim 1 thru/or the complex-dielectrics materials according to claim 5.

They are a radiation electrode and a ground electrode to the surface of this antenna base.

---

[Translation done.]

# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-215732

(43)Date of publication of application : 04.08.2000

(51)Int.Cl.

H01B 3/00  
C08L 21/00  
C08L 25/06  
C08L 67/03  
H01B 3/42  
H01B 3/44  
H01Q 13/26

(21)Application number : 11-015265

(71)Applicant : MURATA MFG CO LTD

(22)Date of filing : 25.01.1999

(72)Inventor : SAKURADA KIYOYASU  
HARADA ATSUSHI  
KIMURA KOJI

## (54) COMPLEX DIELECTRIC MATERIAL AND DIELECTRIC ANTENNA USING IT

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide complex dielectric material and dielectric antenna having high thermal resistance, improved electric characteristic, improved workability, improved formability and small specific gravity.

**SOLUTION:** A dielectric antenna 1 is composed of a rectangular parallelepiped shape antenna substance 2, an input electrode 4, a radiation electrode 5 and a ground electrode 6. Complex dielectric material comprising inorganic filler soluble to at least one of acid and alkali mixed into matrix resin mixed styrene polymer having syndiotactic structure and liquid crystal polyester resin is used for material for the antenna substance 2. The complex dielectric material whose the matrix resin is 35-99 volume%, the inorganic filler is 1-45 volume%, volume ratio of styrene polymer and liquid crystal polyester resin of the matrix resin is 0.25-4.0 is suitable.

